United States Patent [19]

Labedan et al.

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[45] **Date of Patent: Apr. 7, 1987**

[54] **NEEDLE BEARING AND IN PARTICULAR A NEEDLE SLEEVE HAVING A REINFORCED SEAL**

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[21] Appl. No.: **759,649**

[22] Filed: **Jul. 26, 1985**

[30] **Foreign Application Priority Data**

Jul. 30, 1984 [FR] France 84 12083

[51] **Int. Cl.**[4] **F16C 33/76**; F16J 9/06

[52] **U.S. Cl.** **384/486**; 384/564; 277/152; 277/205

[58] **Field of Search** 277/152, 205; 384/130, 384/147, 151, 153, 477, 484–486, 488, 489, 564

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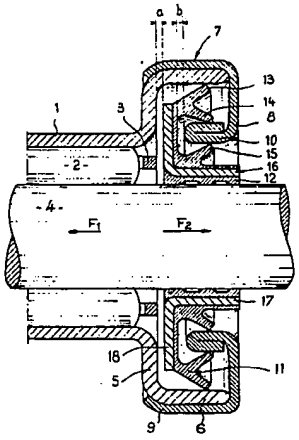
[57] **ABSTRACT**

A needle bearing, and in particular a needle sleeve, comprising an outer ring (**1**) in which are mounted needles (**2**) contained in a cage (**3**), sealing means being provided at the ends of the outer ring, wherein said sealing means comprise a sealing element (**11**) of an elastomer having a sleeve (**12**) adapted to receive by a tight fit the inner element (**4**) of the bearing, and peripheral sealing lips (**13, 14, 15**) cooperative with the axial surfaces of a flange (**5**) having an axial ledge (**6, 7, 8, 10**) of the outer ring in which the sealing element (**11**) is disposed, an axial inner portion (**10**) of the flange constituting an abutment for the axial relative displacements of the outer ring (**1**) and the inner element (**4**) of the bearing.

7 Claims, 3 Drawing Figures



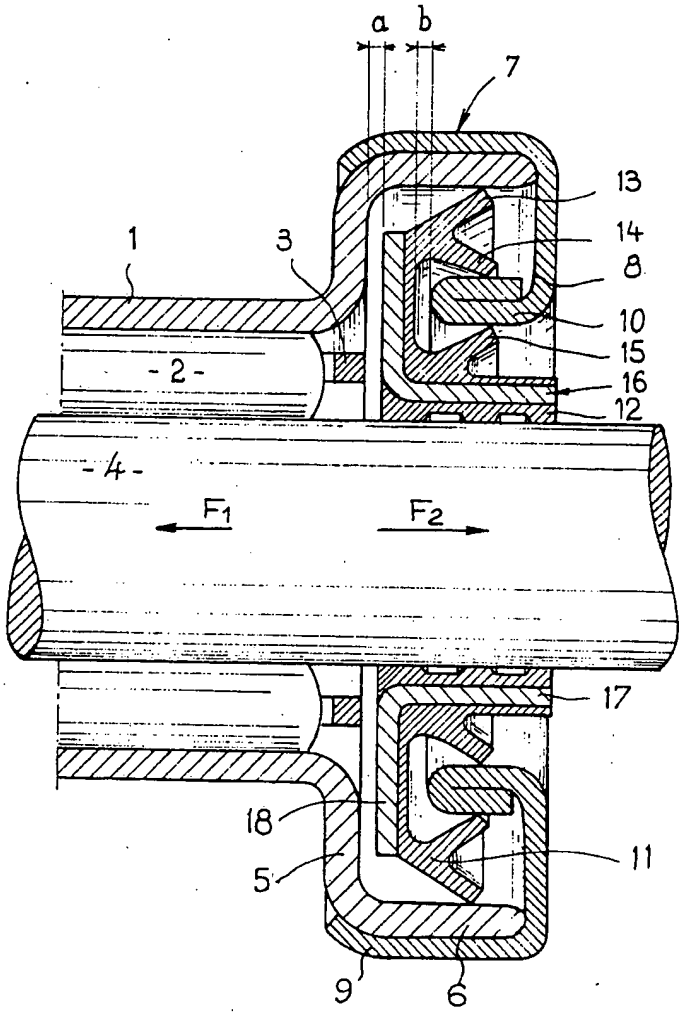


FIG. 1

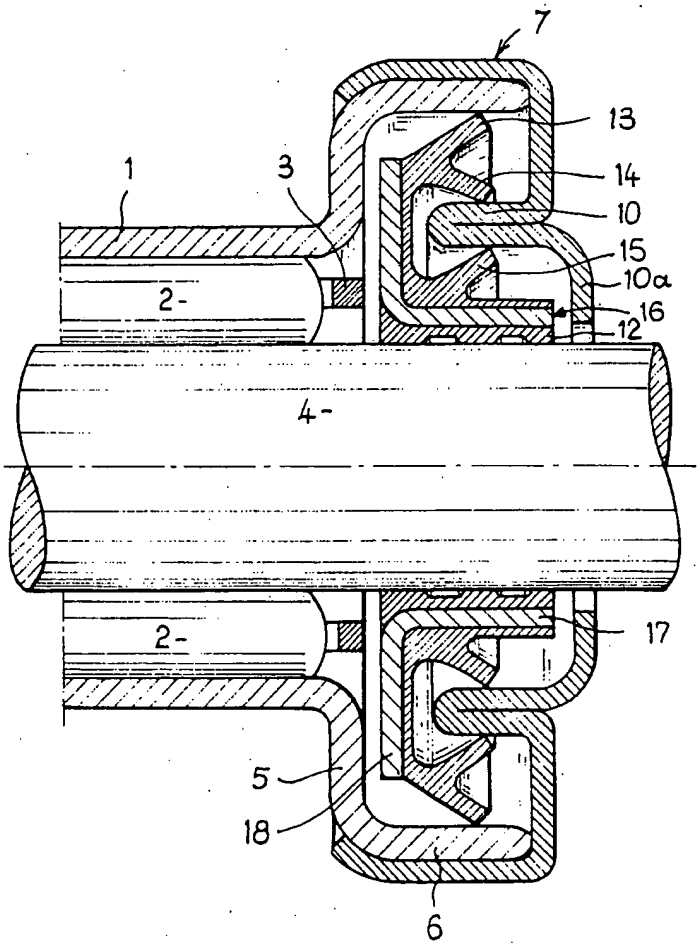
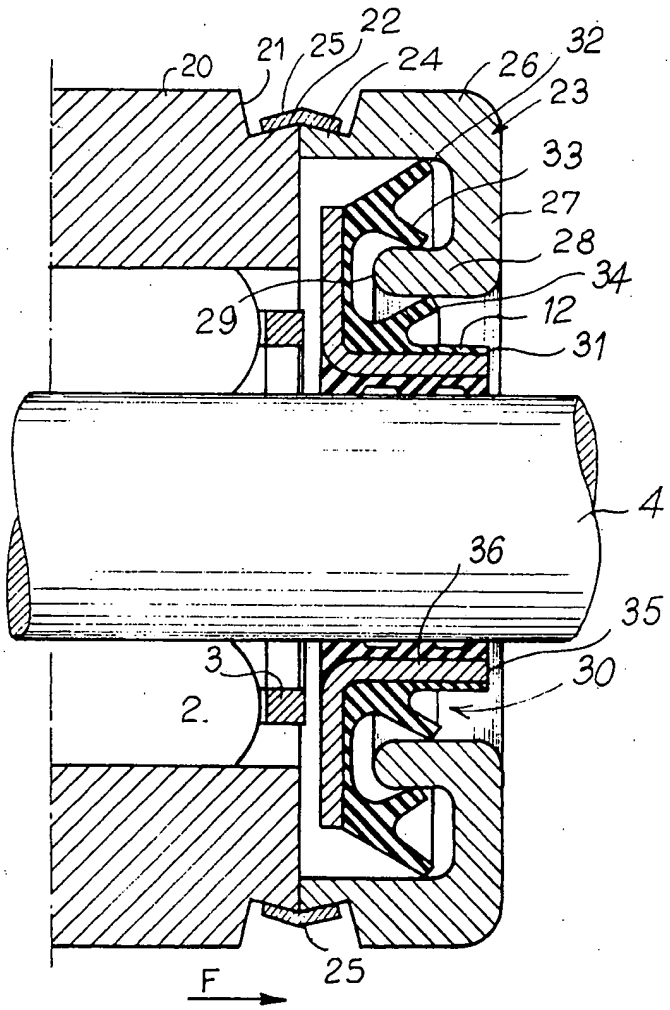


FIG. 2

FIG.3



NEEDLE BEARING AND IN PARTICULAR A NEEDLE SLEEVE HAVING A REINFORCED SEAL

The present invention relates to needle bearings and more particularly to needle sleeves having a reinforced seal.

A needle sleeve is usually formed by a ring arrangement of needles disposed in a cage and mounted in a sleeve whose inner surface forms the outer rolling track or race of the assembly.

A shaft is rotatively mounted within the ring arrangement of needles.

There are sealing problems in such a needle sleeve at the ends of the sleeve forming the outer rolling track, above all in certain applications in which the shaft moreover undergoes an axial movement of small extent, for example on the order of 1 to 2 mm.

An object of the invention is to provide a needle sleeve provided with efficient sealing means, even when the sleeve or outer ring and the shaft undergo relative axial movements.

The invention therefore provides a needle bearing, and in particular a needle sleeve, comprising an outer ring in which rolling elements are mounted, sealing means being provided at at least one end of the outer ring, wherein said sealing means comprises a sealing element of an elastomer including a sleeve portion adapted to receive by a press fit the inner element of the bearing, and peripheral sealing lips cooperative with the axial surfaces of a flange an attached member having an outer axial ledge associated with the outer ring and in which said sealing element is disposed, an axial inner ledge of said attached member constituting an abutment limiting relative axial displacements of the outer ring and the inner element of the bearing.

A better understanding of the invention will be given by the following description which is given solely by way of example with reference to the accompanying drawings, in which:

FIG. 1 is a partial elevational and sectional view of a needle sleeve according to a first embodiment of the invention;

FIG. 2 is partial elevational and sectional view of a second embodiment of the needle sleeve according to the invention, and

FIG. 3 is a partial elevational and sectional view of an embodiment comprising machined parts of the needle sleeve according to the invention.

The needle sleeve shown in FIG. 1 comprises an outer ring 1 in which is mounted a ring arrangement of needles 2 disposed in a cage 3. The ring arrangement of needles may also be formed by adjoining needles without a cage.

The inner surface of the ring constitutes the outer rolling track or race for the needles 2 and an inner element of the bearing or a shaft 4 is rotatively mounted within the ring arrangement of needles.

The shaft 4 undergoes furthermore an axial movement of small extent, for example, on the order of 1 to 2 mm.

At one of its ends, the outer ring 1 has a flange 5 including an axial ledge or an annular wall 6 which extends axially beyond the needles 2 and the cage 3.

Fixed on the axial ledge 6 by a forming-over method is an attached annular member 7 provided with a radial ring-shaped portion 8, an outer axial portion 9 by which it is fixed to the ledge 6 of the flange 5 and an inner axial portion or an axially extending ledge 10 having an end portion which is formed-over onto itself.

In the spaces defined between the axial ledge 6 of the flange 5 and the inner axial portion 10 of the attached member 7, on one hand, and between this axial portion 10 and the shaft 4, on the other hand, there is interposed a sealing element 11.

This sealing element 11 comprises an elastomer part provided with a central sleeve 12 mounted with a tight fit on the shaft 4 and three axial peripheral sealing lips 13, 14 and 15 which are respectively in contact with the inner surface of the axial ledge 6 of the flange 5, the outer surface of the inner axial portion 10 of the attached member 7 and the inner surface of this inner portion 10.

The triple seal is reinforced by a reinforcement 16 formed by a tube 17, embedded in the material of the elastomer sleeve 12, and a radial flange 18.

The reinforcement 16 is fixed to the sealing element by, for example, bonding or vulcanization.

In operation, the sealing element is immobilized relative to the shaft 4 by the gripping of the elastomer sleeve 12.

The possibility of axial displacement of the assembly thus defined is equal to the sum of the distances a and b respectively between the flange 5 of the sleeve 1 and the surface of the flange 18 of the reinforcement 16 in confronting relation to the flange 5 and between the opposed surface of the flange 18 and the end of the axial inner portion 10 of the attached member 7.

When the shaft 4 is inserted in the bearing, the whole of the sealing element is driven by the gripping of the sleeve 12. If the insertion of this shaft occurs in the direction of the arrow F_1, the sealing element abuts by its flange against the flange 5 of the sleeve 1.

If the insertion occurs in the direction of the arrow F_2, the sealing element 11 abuts by its radial portion against the end of the axial inner portion 10 of the attached member 7.

Thus it can be seen that, irrespective of the direction of insertion of the shaft in the bearing, the sealing lips 13, 14 and 15 are not liable to be damaged during the assembly.

FIG. 2 shows a needle sleeve which constitutes a modification of the needle sleeve shown in FIG. 1.

According to this modification, which is substantially similar in every respect to the sleeve shown in FIG. 1, the attached member 7 includes a radial portion 10*a* extending from the axial inner portion 10 and constituting a deflector protecting the assembly against projections of soiling elements.

It will be seen that the arrangement just described permits the obtainment of a needle bearing which combines a good seal with a tolerance of axial displacement of the shaft relative to the outer ring with no danger of damage to the sealing means.

The embodiments described with reference to FIGS. 1 and 2 are rolling bearings whose outer ring and attached member are made by a press operation.

The invention is also applicable to massive rolling bearings.

The needle sleeve shown in FIG. 3 differs from the embodiments described with reference to FIGS. 1 and 2 in that it includes a massive outer ring 20 at at least one of the ends of which is formed by machining a groove defining a frustoconical edge portion 22 whose large base defines the corresponding end of the sleeve. The edge portion 22 is extended by an attached annular

member 23 which is also massive and also includes a frustoconical edge portion 24 whose large base is applied against the large base of the edge portion 22 of the ring 20.

The two edge portions 22 and 24 are interconnected by a setting or forming-over of an assembly collar 25.

The annular member 23 includes an axial outer portion 26 which lies in the extension of the outer ring 20 and defines the annular wall, a radial portion 27 and an inner axial portion 28 whose inwardly facing end 29 forms an abutment for the axial displacements in the direction of arrow F of the outer ring relative to the shaft 4 on which it is mounted.

In the spaces defined between the outer and inner portions 26 and 28 of the annular member 23, on one hand, and the inner portion of this member and the shaft 4, on the other hand, there is interposed a sealing element 30 of an elastomer similar to the sealing elements described with reference to FIGS. 1 and 2 and including a central sleeve 31 mounted with a tight fit on the shaft 4 and three axial peripheral lips 32, 33, 34 which are respectively in contact with the inner surface of the outer portion 26, with the outer surface of the inner axial portion 28, and with the inner surface of the inner axial portion 28 of the member 23.

As in the foregoing embodiments, this triple seal is reinforced by a reinforcement 35 consisting of a tubular portion 36 embedded in the material of the sleeve 31 of elastomer and a radial flange 37, the reinforcement being fixed to the sealing element by bonding or vulcanization.

We claim:

1. A needle bearing comprising: an outer ring, needles mounted in the outer ring, an inner element rotatably mounted in the outer ring and surrounded by the needles, and sealing means disposed at at least one end of the outer ring, said sealing means comprising means defining an annular wall disposed at the end of the outer ring and having an axially extending annular inner surface, an attached member radially and inwardly extending from said annular wall and having at a radially inner end of the attached member an axially extending ledge defining inner and outer axially extending surfaces, and a sealing element composed of an elastomer and including a sleeve portion adapted to receive the inner element of the bearing with a tight fit, the sealing element having three peripheral sealing lips disposed around the sleeve portion, each being in contact with the axially extending annular inner surface of the annular wall, the outer axially extending surface of the ledge and the inner axially extending surface of the ledge respectively, said sealing element being disposed against the ledge, said ledge constituting an abutment for relative axial displacements between the outer ring and said inner element of the bearing.

2. A needle bearing according to claim 1, wherein the attached member defines said axially extending ledge and has an outer axially extending portion which is fixed to the end of the outer ring.

3. A needle bearing according to claim 2, wherein the attached member further comprises a radially extending portion extending from the inner axially extending ledge thereof and constituting a deflector.

4. A needle bearing according to claim 1, wherein the sealing element comprises a reinforcement having a tubular portion embedded in the elastomer of said sleeve of the sealing element and a radial flange supporting the peripheral sealing lips of the sealing element, the reinforcement being fixed to said elastomer of the sealing element by bonding or vulcanization.

5. A needle bearing according to claim 2, wherein the end portion of said outer ring defining a flange and said attached member comprise press-formed elements, said flange defining the annular wall.

6. A needle bearing according to claim 2, wherein the outer ring and the attached member comprise machined massive parts, the outer axially extending portion of the attached member defining the annular wall.

7. A needle bearing according to claim 6, wherein each of the massive parts comprises a frustoconical edge portion having a large base which constitutes the end of the corresponding part, the edge portion of said attached member being disposed in the extension of the edge portion of said outer ring, and a formed-over assembly collar interconnecting said outer ring and said attached member by surrounding said two frustoconical edge portions.

* * * * *

United States Patent [19]

Jackowski et al.

[11] **4,448,426**

[45] **May 15, 1984**

[54] **UNITIZED OIL SEALS**

[75] Inventors: **Ronald A. Jackowski**, Algonquin; **Glenn W. Peisker**, Barrington, both of Ill.

[73] Assignee: **Chicago Rawhide Manufacturing Company**, Elgin, Ill.

[21] Appl. No.: **280,888**

[22] Filed: **Jul. 6, 1981**

[51] **Int. Cl.**[3] **F16J 15/34**

[52] **U.S. Cl.** **277/37**; 277/153

[58] **Field of Search** 277/35, 37, 152, 153, 277/147, 148

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Primary Examiner—Robert I. Smith

Attorney, Agent, or Firm—James T. FitzGibbon

[57] **ABSTRACT**

A unitized oil seal with inner and outer rigid casings. A seal lip body with primary and auxiliary sealing lips is bonded to the outer casing, and the sealing lip cooperates with an axial flange on the inner casing to provide a fluid-tight seal band area. The outer casing includes an auxiliary rubber or metal element which positions a locking flange on the inner casing against axial displacement. The axial flange on the inner casing has a radially inturned edge on the end opposite the locking flange to facilitate assembly. The inside diameter of the inner casing and the outside diameter of the outer casing include rubber or plastic sleeves for ease of installation on an associated sealed mechanism.

13 Claims, 13 Drawing Figures

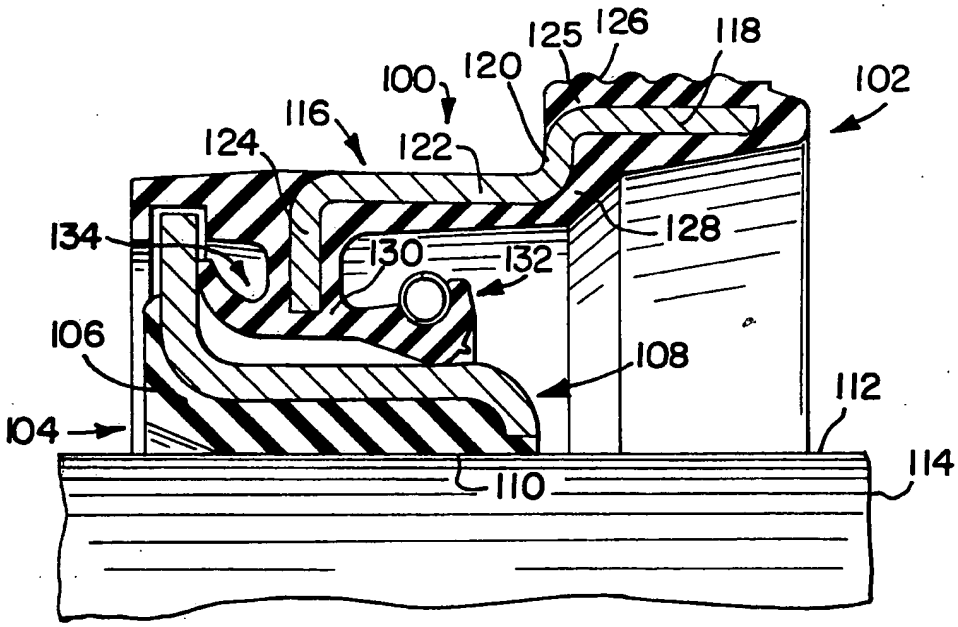
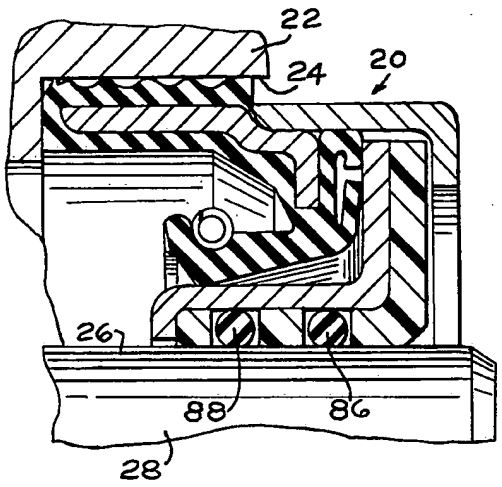


FIG. 1



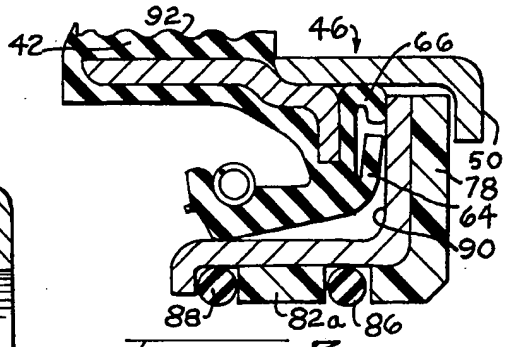


FIG. 3

FIG. 2

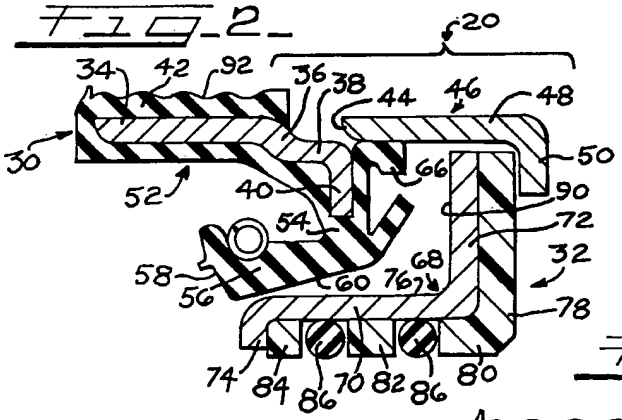


FIG. 5

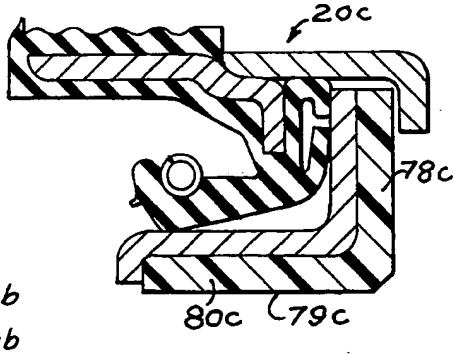
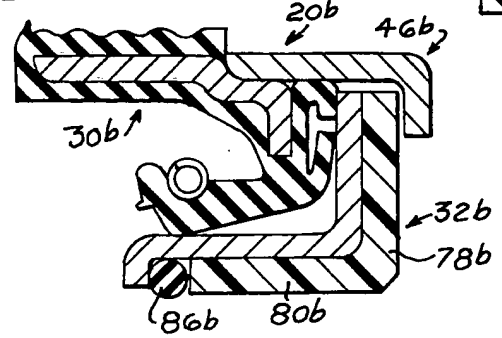


FIG. 4



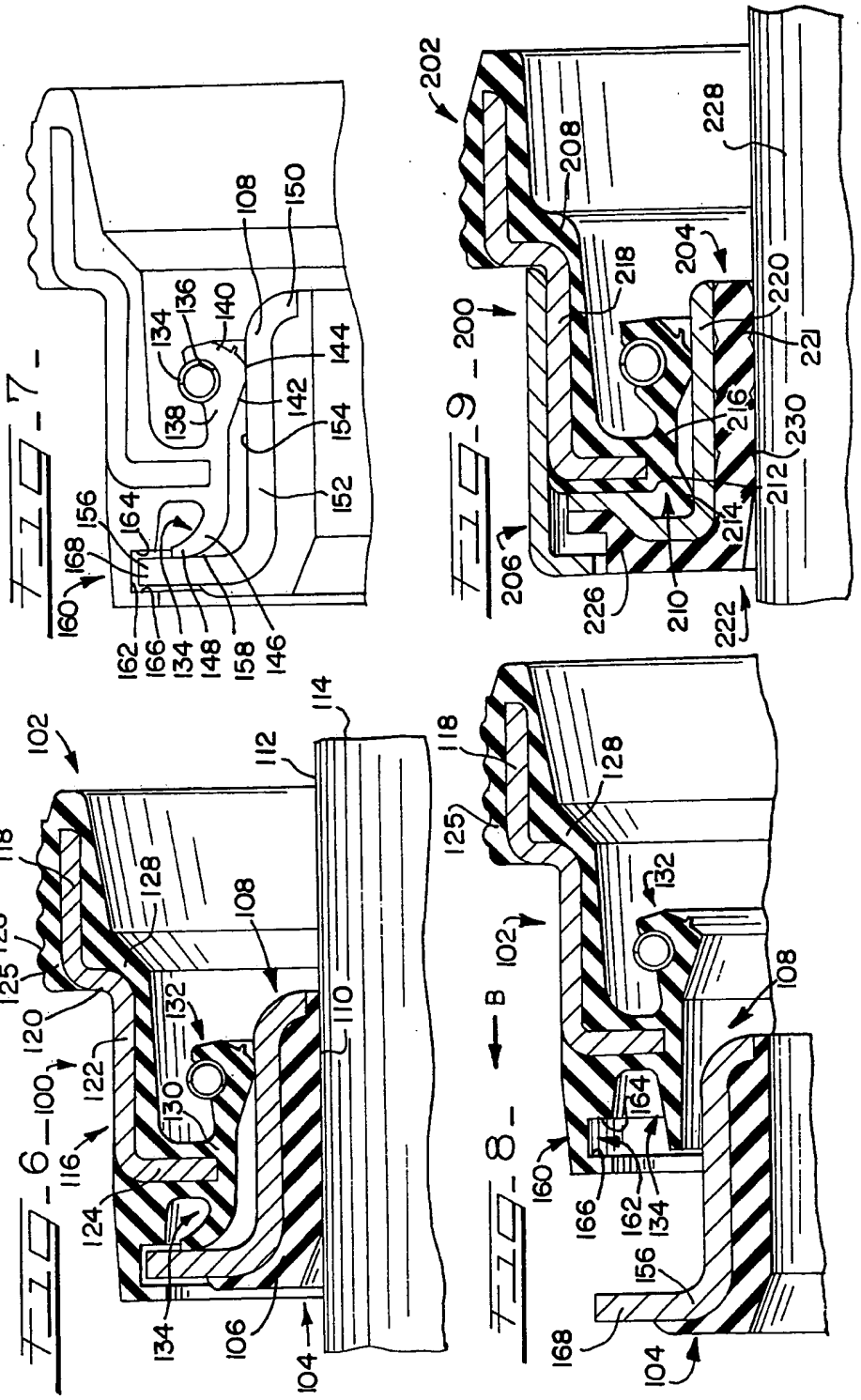


FIG. 7
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FIG. 9
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FIG. 6
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FIG. 8
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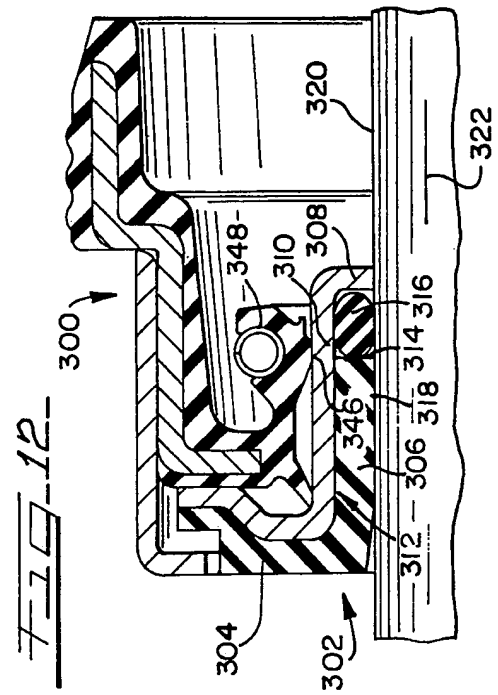

FIG. 12

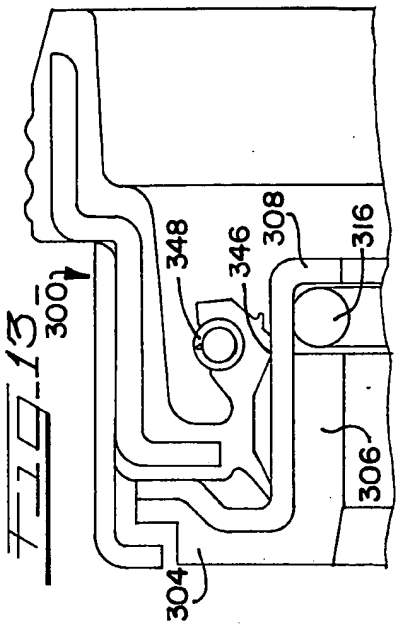

FIG. 13

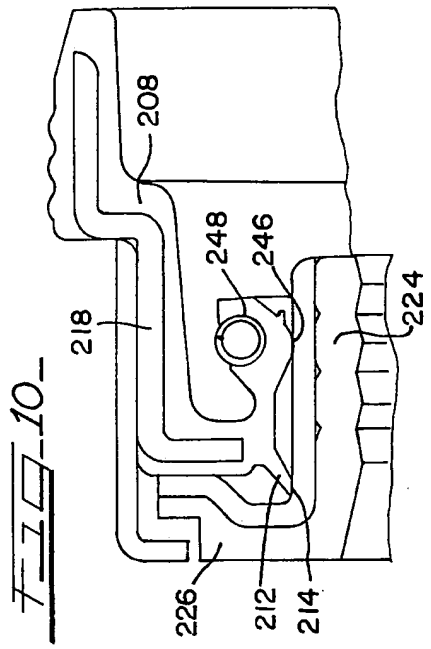

FIG. 10

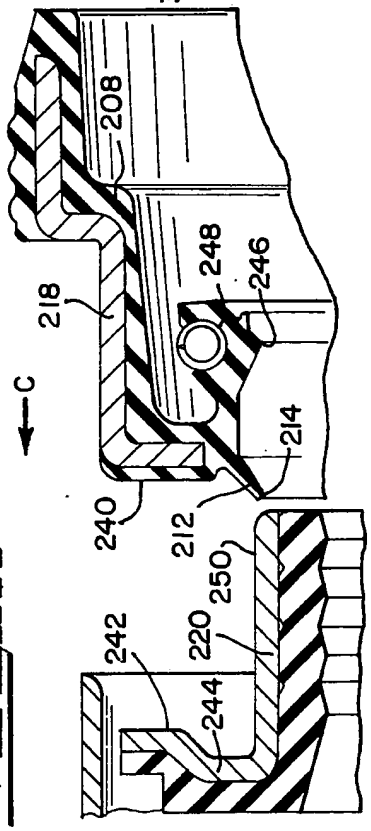

FIG. 11

UNITIZED OIL SEALS

The present invention relates generally to oil seals, and more particularly, to so-called unitized oil seals intended specifically for motor vehicles and related applications.

By "unitized" as used herein is meant oil seals in which the primary sealing lip portion and the portion with which such sealing lip is associated in use to form a relatively movable or so-called primary sealare both incorporated within a single oil seal which is sold as a unit. The primary seal may, but need not, also include one or more auxiliary lips, sometimes referred to as "dirt lips" or "excluder lips", the function of which is to keep dirt from the vicinity of the primary lip. Accordingly, the control over the primary seal conditions may be accomplished by the manufacturer, rather than depending upon cooperation between parts manufactured by a seal maker and parts manufactured by the user, such as manufacturers of axles, housings, bearings, shafts, or the like.

Oil seals of the type with which the present invention are concerned also normally include two so-called secondary seals, that is, seals wherein relative motion does not take place. One such seal is on a relatively movable part such as an axle or the like, and the other is on a stationery part, such as a housing. In certain other cases, such as in heavy trucks, while the seal assembly includes two portions adapted to form secondary seals, the shaft is sometimes a stationary part and the counterbore or the like is formed in a cap which rotates with the wheel. Because one seal part engages a radially inner sealed component and the other engages an outer component, the seal elements may be referred to "inner" and "outer" elements for convenience.

In any case, problems in sealing applications of the type with which the invention are concerned relate to improper sealing conditions which may be caused by installation of the seal, by handling of the seal after manufacture and before or during shipment, and by leakage which is occasioned by improper relative fit between parts, improper positioning, or improper manufacture of one or both of the sealed parts.

According to the invention, an easy to install, highly reliable secondary seal is formed on the inside diameter of the unitized seal of the invention, and a similar seal is formed on the outside diameter of the seal, with the primary or relative motion seal occurring between parts of the two members forming the unitized seal. According to the invention, both the inner and outer seal elements have cooperating means associated therewith to insure that the seal may be shipped and installed as a unit, and accordingly, there is a slight axial play or movement permitted between parts, but this free play is kept within designed tolerances during shipping, installation and actual use of the seal.

Referring to the prior art, while unitized seals have met with considerable success, including seals of the type described in U.S. Pat. No. 3,762,726, such seals have often been rather difficult to install without the use of special tools. Accordingly, their use has been generally limited to original equipment manufacture applications, and those replacement applications in which the repair or rebuilding facility has the equipment necessary to make the installation.

Needless to say, in applications wherein the seal itself is of large diameter and overall size generally, and is required to have portions placed over stub shafts or the like, as well as portions adapted to be received within a counterbore, the seal tends to be made from rather heavy gauge metal parts. Installation of parts of this sort under tight secondary seal conditions ften requires the application of considerable force. Where this is true, it is very important that the seal be aligned properly before the force is applied, and that means be provided to insure that the seal is not cocked or otherwise installed irregularly in relation to the sealed parts.

Because of the difficultly in installing seals of this type, there has existed in the prior art a need for a seal which is easy to install but which, when installed, is highly reliable in use. There has also been a need for manufacturing a seal which may be installed reliably at low cost and which does not require the use of highly precise components, yet which achieves excellent reliability in sealing. In this connection, it will be appreciated that the cost of seals is relatively low in relation to the cost of the sealed parts, and that an improperly installed seal, or one that leaks prematurely in use, requires labor and other repair cost which are very great in relation to the cost of the seal itself.

In addition, warranty replacement costs themselves create potentially serious problems, including those of legal liability, warranty claim handling cost and, viewed from the standpoint of the consumer, a poor image of the manufacturer. Replacing seals also means that equipment down time will occur, causing additional expense and inconvenience to the user.

Accordingly, in view of shortcomings of prior art seals, it is an object of the present invention to provide an improved unitized seal.

Another object of the invention is to provide a unitized seal having inner and outer casing elements, with each element including an associated mounting portion adapted to provide a snug, fluid tight seal with associated machine parts.

A still further object is to provide a unitized seal having inner and outer assemblies each adapted to be associated in use with a machine part, with at least one of the assemblies using a plurality of elements adapted to cooperate with each other and the sealed parts to insure an easy, low cost, reliable installation which can be accomplished without the use of special tools or equipment.

A further object is to provide a unitized seal which is easy to install and yet which has all of the favorable operating characteristics of prior art unitized seals, and in some cases, operating characteristics which are further improved with respect thereto.

Another object of the invention is to provide a unitized seal having a radially inner element which includes a casing portion, means for locating a secondary seal element in a captive position, and one or more secondary seal forming elements retained within said positioning means and adapted to create a tight secondary seal in use.

A still further object of the invention is to provide a unitized seal having inner and outer casing elements, having means providing free but limited axial movement between these parts, and providing an elastomeric outer diameter seal portion for easy but fluid tight installation with a portion of the sealed mechanism.

A still further object of the invention is to provide a unitized seal having a variety of improved mechanisms for achieving a satisfactory secondary seal.

Yet another object is to provide a unitized seal which will provide one or more secondary seals which combine ease of installation with good sealing action, and in some cases, which utilize novel materials and components for this purpose.

The foregoing and other objects and advantages of the invention are achieved in practice by providing an easily installed, unitized seal assembly which includes inner and outer mounting assemblies and, associated with one of said mounting assemblies, a primary seal lip unit, and with the other of said assemblies, a cooperating seal surface, with said inner and outer mounting assemblies each having means for secondarily sealing an associated part of a mechanism to be sealed, said unit further including cooperative means for unitizing said seal against undesired axial movement of said mounting assemblies relative to each other so as to maintain said seal lip and said cooperating surface in axially aligned relation.

The manner in which the foregoing and other objects of the invention are carried into practice will become more clearly apparent when reference is made to the accompanying detailed description of the preferred embodiments set forth by way of example, and shown in the accompanying drawings, wherein like reference numbers indicate corresponding parts throughout.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical sectional view of a portion of an oil seal made according to the invention, and showing one part of the seal received in an associated machine part counterbore and showing a portion of a shaft receiving the other part of the seal assembly;

FIG. 2 is a partially exploded view of the seal assembly of FIG. 2;

FIG. 3 is a vertical sectional view of the seal of FIG. 1, showing the seal unit as sold and delivered by the manufacturer;

FIG. 4 is a vertical sectional view of another embodiment of the composite seal unit of the invention;

FIG. 5 is a vertical sectional view of a portion of a still further modified form of oil seal embodying the invention;

FIG. 6 is a vertical sectional view, with portions broken away, of a preferred form of oil seal made according to the invention and showing the seal associated with a shaft or the like.

FIG. 7 is a view of the seal of FIG. 6, but showing the seal without cross-hatching for clarity.

FIG. 8 is a vertical sectional view of the seal of FIG. 6, but showing the same in a partially exploded or disassembled relation;

FIG. 9 is a vertical sectional view of a still further form of a seal made according to the invention and showing the seal in assembled position of use with an associated shaft;

FIG. 10 is a view of the seal of FIG. 9, shown without cross-hatching;

FIG. 11 is a vertical sectional view of the seal of FIGS. 9 and 10 showing the components thereof in partially exploded relation;

FIG. 12 is a vertical sectional view of a portion of a still further form of seal made according to the invention; and

FIG. 13 is a view of the seal of FIG. 12, shown without cross-hatching.

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

While it will be understood that the invention may be embodied in a number of different forms, and that the seal of the invention is capable of being used in a number of applications, a detailed description of the invention will be given wherein the seal is used in a heavy duty truck or like application; wherein the sealed medium is oil, and wherein the primary lip seal is a radially inwardly acting seal unit. As pointed out above, either the radially inner or the radially outer portion of the seal may be associated with a movable machine member, and the other portion will then be associated with a fixed or non-rotatable machine member.

Reference is sometimes made herein to axially "inner" or "outer", or to the "air side" or "oil side" of the seal. As is known in the art, the so-called "oil side" of the seal is the portion of the seal facing toward the sealed region, and "axially inner" refers to the direction lying toward such sealed region.

In FIGS. 1–5, for example, the sealed region lies to the left and in FIGS. 6–13, it lies toward the right; the more steeply inclined surface of the seal lip generally lies on the oil side, and, if the sealed region were completely filled with oil, the garter spring would be in contact therewith. Portions on the air side of the seal would not be so exposed.

Referring now to the drawings in greater detail, FIGS. 1–3 show one embodiment of a unitized seal assembly made according to the invention. The seal assembly generally identified as 20 is shown to form a seal between a relatively fixed or rotatable machine element 22 having a seal-receiving counterbore 24 therein and the radially outer surface 26 of a fixed or rotatable shaft 28.

The seal assembly 20 includes a radially outer seal assembly generally designated 30 (FIG. 2) and a radially inner seal assembly generally designated 32. The outer seal unit 30 includes a rigid mounting flange 34 which is of an annular configuration and which extends axially a length approximately equal to the axial depth of the counterbore 24.

Axially outwardly of the rigid mounting flange 34 is a shoulder 36 terminating in a collar 38 of reduced diameter, and axially outwardly thereof is a radially inturned, seal body mounting flange 40. The flange 34 supports a portion 42 of the elastomeric seal body which will engage the counterbore surface 24 to form a tight seal thereagainst. The should 36 serves as an abutting surface to limit the axial travel of the nose 44 of the metal unitizing collar generally designated 46 and shown to include axial and radial flanges 48, 50 (FIG. 2). As shown in FIG. 3, when the nose 44 and the radially inner surface of the flange 48 are associated with the shoulder and collar 36, 38, respectively, these sealed parts are locked together as a unit.

An elastomeric seal body generally designated 52 includes the portion 42 referred to earlier, as well as a radially extending neck portion 54 which surrounds the radially extending seal lip mounting flange 40. The primary seal lip body 56 includes an oil side surface 58 and an air side surface 60, each of frustoconical configuration and meeting at a seal band area 62. A secondary or dirt lip 64 also forms a part of the elastomeric seal body 52 as does a contoured snubber or spacer 66, the purpose of which is referred to herein. Referring again to FIG. 2, radially inner mounting assembly 32 is shown

to include an annular metal portion generally designated 68 and shown to include axial and radial flanges 70, 72 and a second inner radial flange 74. The radially outer surface 76 of the axial flange 70 cooperates with the seal band 62 to form the primary seal, that is, the seal created between relatively movable parts.

A generally annular plastic member 78 having an L-shaped cross-section is shown to have portions bonded to the outer radial flange 72. Spaced axially inwardly from the axial flange 80 of the element 78 are a pair of relatively rigid locating rings 82, 84 of secondary seal means in the form of compressible square or rectangular cross-section which serve to confine a pair of elastomeric O-rings 86, 88.

When the components of FIG. 2 are assembled, as by exerting an axial force on the elements 32, 46 in the direction shown by the arrow "F" (FIG. 2), a unitized seal of the general form shown in FIG. 3 will result. Here, it is shown that the unitizing collar assembly 46 has been pressed into place to hold the units together.

The dirt lip 64 has been flattened (made more radial) by contact with the radial surface 90 of the flange 72, and the snubber 66 is shown to engage the flange 72 to prevent undue axially inward movement of the assembly 32. The radial flange 50 on the unitizing assembly 46 is then spaced just apart from the plastic flange.

When a seal such as that shown in FIGS. 2 and 3 is assembled over a shaft such as the shaft 28, an assembly such as that shown in FIG. 1 results.

While the seals of FIG. 1 and 2 are shown to be identical, the seal of FIG. 3 is illustrated as being virtually identical, except that the locating ring 82*a* is shown as being wider than its counterpart 82 in FIG. 2 and the ring 84 of FIG. 2 has no counterpart in the seal of FIG. 3. Otherwise, the assemblies including the O-rings 86, 88 are the same. The flange 74 in FIG. 3 serves the same purpose as the ring 84 in FIGS. 1 and 2.

As installed, the outer surface 92 of the rubber body 42 may more or less tightly engage the counterbore 24, and the O-rings 86, 88 will be deformed sufficiently to form the seal by the contact with the surface 26 of the shaft 28.

In considering FIGS. 1–3, it will be seen that one form of seal made according to the invention include a first seal assembly having portions adapted to be received within a counterbore, another portion adapted to cooperate with the seal lip to form the primary seal, and third portion to comprise a unitizing element. The second portion includes a shaft-engaging portion and a companion flange for cooperation with the seal lip to form the primary seal, while the unitizing assembly is adapted to hold the first and second parts in assembled relation for shipping, handling and installation.

Referring now to FIG. 4, a very similar seal assembly generally designated 20*b* is shown. This unit includes a similar mounting assembly 30*b*, unitizing assembly 46*b* and a companion flange or second seal assembly 32*b*. In the embodiment of FIG. 4, the plastic element 78*b* is similar to its counterpart in FIG. 2, for example, except that the radial flange 80*b* is considerably longer, and only a single O-ring 86*b* is used. In other respects, the seal is the safe as its counterpart of FIGS. 1–3. The use and installation of the seal are likewise the same, and the seal of FIG. 4 is typically used where a single O-ring is sufficient to provide the required secondary seal.

Referring now to FIG. 5, a further embodiment of the invention generally designated 20*c* is shown. This unit is identical to the seals of FIGS. 1–4, except that the flange 78*c* is made entirely from a plastic or like material. This unit includes a radially inner plastic face 79*c* adapted to engage an associated shaft, and includes no O-rings at all. This form of seal is suitable for installation where the shaft with which it is associated is precisely ground and wherein the radially extending boy 80*c* of the flange 78*c* can be deformed sufficiently to provide a fluid-tight seal, and yet wherein the parts can be assembled without the use of special tools or applying unusual force. In some cases, the plastic or like material from which the element 78*c* is made may be somewhat more pliable than in its counterpart in the seals of FIGS. 1–4.

FIG. 6 shows an improved form of unitized seal made according to the invention. The seal of FIG. 6, generally designated 100, also includes an outer portion generally designated 102 and an inner portion generally designated 104. The outer assembly 102 includes portions adapted to be received within a counterbore (not shown in FIG. 6). An inner portion 104 of the assembly 100 includes a metal or like rigid companion flange 108 having an elastomeric sleeve 106 bonded thereto. The collar 106 includes an inwardly directed surface 110 adapted to sealingly engage an outwardly directed circumferential surface 112 of a shaft or stub 114.

In the embodiment of FIGS. 6–8, the outer assembly 102 includes a mounting flange generally designated 116 and includes an enlarged diameter axial flange 118, a shoulder 120 and a reduced diameter collar 122, terminating in an inwardly directed or radial flange 124 which serves to mount the elastomeric seal lip assembly.

The rubber portions of the outer unit 102 includes a radially outermost elastomeric outer body 125 with a surface 126 adapted to be received within an associated counterbore in snug sealing relation, an inner body 128 which includes a neck portion 130 from which extends a primary lip seal assembly generally designated 132 and an auxiliary or so-called dirt excluder lip assembly generally designated 134. In FIG. 7, it is shown that the primary seal lip assembly 132 includes a garter spring 135 disposed in a spring groove 136 and that the seal lip body 138 includes oil and air side surfaces 140, 142 respectively of generally frustoconical configuration which meet to define a seal band area 144. The dirt lip 134 includes a sealing body 146 of thin cross-section adapted to provide a flexible lip and terminating in a dirt lip seal edge 148.

As pointed out, the companion flange assembly 104 includes a radially inwardly extending flange 150, an axial flange 152 having a radially outwardly directed surface 154 which operates as a sealing surface for the seal band 144 and which makes sealing contact therewith.

A radial flange portion 156 of the member 106 includes an axially inwardly directed surface 158 adapted to cooperate with the dirt lip 148 to provide an excluder seal.

An important feature of the seal of FIG. 7 is that the unitizing is achieved entirely by means of an elastomeric collar generally designated 160 and shown to include a circumferential groove 162 (FIG. 8) having axially inner and outer wall surfaces 164, 166 which serve to confine the outermost portions 168 of the radial unitizing flange 156. The advantage of the seal assembly of FIGS. 6–8 is that unitizing is achieved without the need for press fitting of metal parts. The rigidity of the elastomeric collar 160 is such that it will effectively unitize the seal, but that it will not require special assembly

techniques involving metal-to-metal assembly as would be required in assembling the seals of FIGS. 1-5, for example.

Referring again to FIG. 8, the seal of FIGS. 6 and 7 is shown in a disassembled form. When an axial force is applied in the direction to move the outer assembly 102 in the direction shown by the arrow "B", the flexible elastomeric collar 160 snaps over the outermost portion 168 of the metal flange 156, locking the two elements together and positioning the seal band 144 in the desired relation to the surface 154 with which it will cooperate to form the primary seal.

As the same time, the dirt lip 134, which is shown as extending axially in FIG. 8, engages the curved transition surface portion of the stiffener 152 and rides therewith upwardly and radially outwardly until it is deformed as schematically shown in FIGS. 6 and 7. Consequently, its own resiliency, urging it to a relaxed position, provides a good secondary reaction sealing force.

The seal assembly of FIGS. 6-8 may thus be manufactured and assembled without the need for precisely matching the diameters of the associated metal stampings, and without the need for form a third or unitizing member from metal for this purpose. When the seal is installed, there is little if any tendency for the parts to become separated, and the unitizing assembly 160 is more than sufficient for holding the seal together after assembly for shipment and installation purposes.

Referring now to FIG. 9, a composite seal unit generally designated 200 is shown to be provided and to be similar in concept to the other embodiments shown. Generally, this seal includes an outer mounting assembly 202, an inner mounting assembly generally designated 204, and a unitizing member generally designated 206. The outer mounting rubber body portion 208 is the same as its counterparts in FIGS. 1-8, except that the dirt lip generally designated 210 in FIG. 9 is of the conventional type seen in ordinary oil seals, that is, it includes a flexible lip portion 212 terminating at a contact locus 214 radially inwardly of the seal body 216. In the seal of FIG. 9, the same reduced diameter unitizing collar 218 is provided for reception of the sleeve or unitizing member 206. The basic differences between the seals of FIG. 9, and those of FIGS. 1-5 are that the inner member 204, in addition to possessing the stiffener 220, includes a manually removable rubber body generally designated 222 and shown to include axial and radial flanges 224, 226.

Since the body 222 is elastomeric, it may be sized to be press fit over the shaft 228. If necessary, circumferential grooves 230 may be provided to reduce the overall compressive stiffness of the body 222, with such grooves 230 being provided on both the inner and outer diameters of the axial flange 224.

The seal shown in FIG. 9 may be assembled in the same way as its counterparts, namely, by co-axially aligning the inner and outer elements as shown in FIG. 11, moving them axially together as by movement in the direction of arrow "C" shown in FIG. 11, and then press fitting the unitizing member in place as shown. The rubber bumper surface 240 (FIG. 11) engages an offset surface 242 on the radial flange 244 of the stiffener 220. As in the other applications, the primary seal is formed between the seal band 246 of the seal lip 248 and a radially outwardly directed surface 250 of the flange 220; the edge 214 of the dirt lip 212 also engages an axially spaced apart portion of this surface 250.

Referring now to FIGS. 12 and 13, an embodiment of the invention generally designated 300 is shown. This seal is identical to that shown in FIGS. 9-11, inclusive, except that the mounting unit for the inner seal portion 302 not only includes an annular locating ring generally designated 302 and shown to include radial and axial flanges 304, 306, but further includes a radial flange 308 extending inwardly from the axial flange 310 of the metal stiffener 312. The end wall 314 of the axial flange 308 of the mounting unit 302 and a wall of the radial flange 308 of the stiffener 310 serve to locate therebetween an elastomeric O-ring 316. The combination of this O-ring and the inner diameter surface 318 of the unit 302 cooperate to affix the seal assembly 300 securely onto the outer diameter 320 of an associated shaft 322.

As shown in FIG. 13, the portions of the seal including the seal band 346, the garter spring 348, etc. are the same as their counterparts in the seals of FIGS. 9-11, for example.

In the use of the present invention, it is possible for the manufacturer to sell, as a unit, a seal which is capable of being installed in relatively heavy duty applications such as truck and trailer axles and the like, by hand or with simple tools. The seal is adapted to use oil as the sealed medium as opposed to grease, and this is a desirable feature for operators seeking extended wheel bearing life.

In those designs using a captive O-ring, advantage is taken of the resiliency of the O-ring and the precision, size and dixensional stability of a plastic inner diameter part. In those seals using a completely elastomeric inner diameter portion, advantage is taken of the use of ribs or the like to increase the general resilience of the unit, and to insure that there is a considerable axial length of rubber in contact with the shaft or stub to seal to provide a tight secondary seal.

Among other specific advantages possessed by one or more seal constructions illustrated and attributable to the present invention are the ease of manufacturing the parts in question, including the ability to remove the parts from the molds in which they are assembled.

In seals made according to the invention, the secondary seal areas are not vulnerable to damage during shipping; however, the seals can be non-destructively disassembled for additional inspection or quality control examination. Thus, while a user would receive an assembled seal which would be unlikely to have seal lip damage, the seal could still be inspected at a quality control point within the purchaser's facility and then be reassembled for handling and installation by personnel employed in assembling the entire sealed mechanism.

The arrangement of the inner and outer diameter rubber formulation is such that the seal is relatively easy to install. It does not require deformation of a metal member for such installation. On the other hand, having the rubber bonded to the metal, secondary sealing problems are reduced and the number of components in the assembly are reduced to two. Accordingly, the rubber components will not separate from the metal components during installation, in contrast to some other, unbonded prior art seals. Accordingly, where freedom from damage during installation and use is an important consideration, together with outstanding seal performance in use, seals of the present invention are highly advantageous, when used on truck and trailer axle seals wherein the sealed assemblies have been converted from the use of grease to the use of oil as the sealed

medium. Inasmuch as the oil lubricated wheel bearing seal is coming into increasingly widespread use, the present invention promises significant economic advantages.

It will thus be seen that the present invention provides a novel seal having a number of advantages and characteristics including those pointed out above and others which are inherent in the invention. A preferred embodiment of the invention having been described by way of illustration, it is anticipated that changes and modifications of the described seal will occur to those skilled in the art and that such changes and modifications may be made without departing from the spirit of the invention or the scope of the appended claims.

We claim:

1. A unitized oil seal assembly comprising, in combination, first and second components adapted to cooperate with each other in use to form said unitized assembly, said first component being a lip-containing assembly and said second component being a companion flange assembly, said first component comprising an annular casing made from a rigid material and having at least one axial flange and one radial flange, a rubber element bonded to and surrounding a portion of said first component casing, said rubber element including an annular portion covering at least a portion of the exterior of said axial flange on said first component casing so as to form a rubber covered, outer diameter, secondary seal-forming surface for said first component, and a seal body portion boned to said first component radial flange, said seal body portion including a primary lip-forming part extending generally axially inwardly from said first component radial flange, said lip forming part comprising oil and air side frustoconical surfaces joined at their inner margins to form a primary lip seal band, and an auxiliary lip forming part extending at least partially axially outwardly of said first component radial flange and being defined by an annular surfaces which cooperate to define the body of said auxiliary lip, said second component including a single rigid casing portion with axial and radial companion flanges, a radially outwardly directed surface of said axial companion flange being sized so as to engage said seal band of said primary lip in fluid-tight relation, with one of said axial and radial surfaces of said companion flange being also sized and positioned to engage said auxiliary lip to form an excluder seal, an annular body of seal-forming material bonded to a radially inwardly directed surface of said axial companion flange and adapted for engagement with an associated machine element, said axial companion flange having a radially inturned flange thereon and forming the axially innermost end thereof, said innermost end being free from radially outwardly extending portions and having a reduced diameter relative to said radially outwardly directed axial flange surface, and unitizing means extending axially outwardly from at least one of said flanges of said first component, said unitizing means having at least one radially extending surface adapted to cooperate with another radially extending portion of said first component to assist in axial positioning of said second component by limiting relative axial movement of said first and second component and to insure mutual engagement of said primary and auxiliary seal lips with sealing surfaces on said companion flange.

2. A seal assembly as defined in claim 1 wherein said unitizing means comprises a third component in the form of a metal casing having an axial flange engaged with a portion of said first component, and a radially inwardly extending flange lying axially outwardly of said radial flange of said second component.

3. An il seal assembly as defined in claim 1 wherein said annular portion of said rubber element surrounding said larger axial flange includes a plurality of grooves formed in the outer diameter thereof to reduce the radial compressive stiffness of said element for ease of installing said first component in an associated machine member.

4. An oil seal assembly as defined in claim 1 wherein said auxiliary lip extends partially radially outwardly and is adapted to engage said radial surface of said companion flange.

5. An oil seal assembly as defined in claim 1 wherein said auxiliary lip extends at least partially radially inwardly and is adapted to engage an axial flange surface of said companion flange.

6. An oil seal assembly as defined in claim 1 wherein said rubber element further includes an axially extending snubber portion bonded to said radial flange of said first component and extending axially outwardly therefrom, said snubber portion being adapted to limit the axial inward movement of said companion flange.

7. An oil seal assembly as defined in claim 1 wherein said annular body of seal forming material is a body made from thermoplastic material.

8. A seal assembly as defined in claim 1, which further includes at least one "O" ring adapted to engage said associated machine element, and wherein said annular body of seal forming material is a body of thermoplastic material constructed and arranged for axially positioning said "O" ring.

9. A seal assembly as defined in claim 1 which further includes a secondary seal forming "O" ring lying radially inwardly of said axial companion flange, said "O" ring being located at least in part by engagement with a portion of said inturned flange on said innermost end of said axial companion flange.

10. A seal assembly as defined in claim 1 wherein said annular body of seal forming material comprises a rubber sleeve having a contoured radially inwardly directed surface for engaging a part of said machine element.

11. An oil seal assembly as defined in claim 1 wherein said unitizing means comprises a molded rubber collar bonded to one of said flanges of said first component and extending axially outwardly therefrom, said collar including means defining a circumferential groove therein for receiving a radially outer portion of said radial companion flange, whereby said unitized assembly is adapted for non-destructive disassembly by deformation of said elastomeric rubber collar.

12. A unitized oil seal assembly comprising, in combination, first and second components adapted to cooperate with each other in use to form said unitized assembly, said first component being a lip-containing assembly and said second component being a companion flange assembly, said first component comprising an annular casing made from a rigid material and having a pair of axial flanges, a radial flange, and a transition flange extending between said axial flanges to define an annular shoulder area, a rubber element bonded to and surrounding a portion of said first component casing, said rubber element including an annular mounting portion covering the larger of said axial flanges on said first component casing so as to form a rubber covered, outer diameter, secondary seal-forming surface for said

first component, a seal body portion including a primary lip forming part extending generally axially inwardly from said first component radial flange and having oil and air side frustoconical surfaces joined at their inner margins to form a primary lip seal band of intended contact with a portion of said second component, and an auxiliary lip defined by annular surfaces extending at least partially axially outwardly of said first component radial flange, said seal body further including a unitizing collar bonded at its axially inner end to said radial flange of said first component, said collar including axially inner and spaced apart walls defining therebetween a circumferential locating groove, said second component including a single rigid casing portion with one axial companion flange and one radial companion flange, said axial companion flange having a center portion and inner and outer axial ends, with said radial companion flange being joined to said axially outer end thereof, with said radially outwardly directed surface of said center portion being sized so as to engage said seal band in fluid-tight relation, with one of said axial and radial companion flange surfaces also being sized and positioned to engage said auxiliary lip to form an excluder seal, a secondary seal-forming portion affixed to at least a radially inwardly directed portion of said axial companion flange center portion and being adapted to form a fluid-tight secondary seal with an associated machine element, with a radially outer portion of said radial companion flange being received within said groove on said unitizing collar for axially positioning said second component and to insure mutual engagement of said primary and auxiliary seal lips with said companion flange, said axially inner end of said axial companion flange being free from any radially outwardly directed portion and having a radially inwardly extending surface portion of reduced diameter relative to the diameter of said axial companion flange center portion surface to prevent seal band damage during relative axial movement of said first and second components during seal assembly.

13. A seal unit as defined in claim 12 wherein said reduced diameter surface on said axially inner end of said companion flange forms a part of a radially inwardly extending end flange element.

* * * * *

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United States Patent [19]

Duckwall et al.

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[45] **Date of Patent: Mar. 21, 1995**

[54] **ANNULAR LUBRICANT SEAL ASSEMBLY**

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[51] **Int. Cl.**[6] **F16J 15/32**

[52] **U.S. Cl.** **277/38**; 277/37; 277/153; 277/50

[58] **Field of Search** 277/37, 38, 47, 50, 277/51, 152, 153

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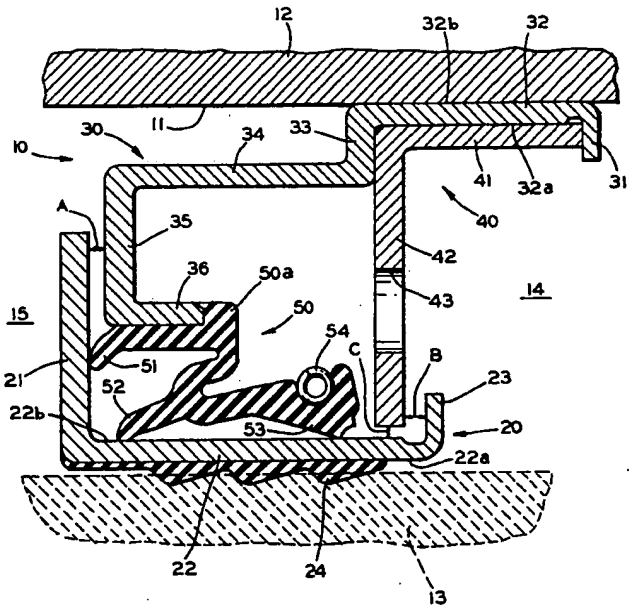
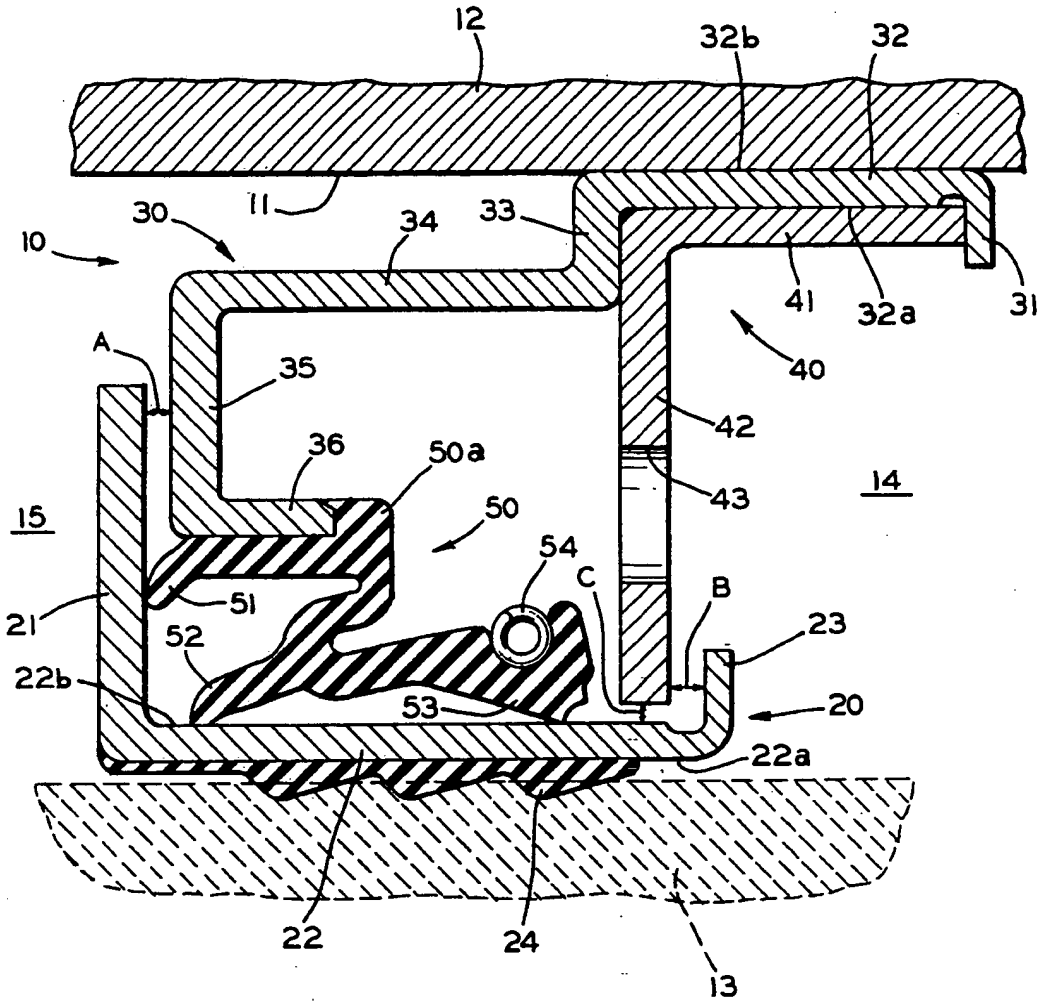
[57] **ABSTRACT**

An annular lubricant seal assembly for an annular lubricant seal assembly for providing a seal between a shaft extending through a bore formed in a housing and the housing, wherein the shaft and the housing are rotatable relative to one another. The seal assembly includes an annular outer case, which is press fit into the bore, and an annular inner case, which is mounted on the shaft. Portions of the outer case extend adjacent to, but are spaced apart from portions of the inner case. An elastomeric seal member is secured to the outer case. Flexible lips formed on the seal member engage both axially and radially extending portions of the inner case disposed adjacent to the outer case. As a result, the seal member is capable of providing a secure seal against the shaft, even when the shaft moves axially or radially relative to the housing during use.

12 Claims, 1 Drawing Sheet

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ANNULAR LUBRICANT SEAL ASSEMBLY

BACKGROUND OF THE INVENTION

This invention relates in general to lubricant seals and in particular to an improved structure for an annular lubricant seal assembly for providing a seal between a shaft extending through a bore formed in a housing and the housing, wherein the shaft and the housing are rotatable relative to one another.

Annular lubricant seal assemblies are typically used in vehicle axle assemblies for providing a seal between a non-rotating axle spindle or shaft and a rotatable wheel hub or housing disposed about the shaft. Lubricant seal assemblies of this type are provided to both to retain lubricant within the wheel hub and to prevent dirt and other contaminants from entering therein. Known lubricant seal assemblies typically include an annular metallic outer case which is press fit within a bore formed in the wheel hub. An annular inner case is mounted concentrically within the outer case. The axle spindle extends through the inner case, which is free to rotate therewith relative to the outer case. A sealing element formed of a resilent material is typically disposed between the outer case and the inner case. This sealing element includes one or more flexible lips which prevent the escape of lubricant from the housing. The sealing element may also include a supplemental flexible lip to prevent contaminants from entering within the wheel hub.

During operation of the vehicle, the wheel hub not only rotates relative to the axle spindle, but also frequently moves both axially and radially relative thereto. Such axial and radial movement can undesirably distort the shape of the sealing element, resulting in a loss of the seal formed by the flexible lips. Also, repetitious axial and radial movements over a period of time can damage the flexible lips. As a result, lubricant may escape from the wheel hub, and dirt and other contaminants may enter therein. Thus, it would be desirable to provide an improved structure for an annular lubricant seal assembly which can accommodate such relative axial and radial movements, while providing a reliable seal between relatively rotatable components.

SUMMARY OF THE INVENTION

This invention relates to an improved structure for an annular lubricant seal assembly for an annular lubricant seal assembly for providing a seal between a shaft extending through a bore formed in a housing and the housing, wherein the shaft and the housing are rotatable relative to one another. The seal assembly includes an annular outer case, which is press fit into the bore, and an annular inner case, which is mounted on the shaft. Portions of the outer case extend adjacent to, but are spaced apart from portions of the inner case. An elastomeric seal member is secured to the outer case. Flexible lips formed on the seal member engage both axially and radially extending portions of the inner case disposed adjacent to the outer case. As a result, the seal member is capable of providing a secure seal against the shaft, even when the shaft moves axially or radially relative to the housing during use.

Various objects and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the preferred embodiment, when read in light of the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

The sole figure is a sectional elevational view of a portion of an annular lubricant seal assembly in accordance with this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, there is illustrated a portion of an annular lubricant seal assembly, indicated generally at **10**, in accordance with this invention. The seal assembly **10** is disposed within a bore **11** formed through a housing **12**. The housing **12** may, for example, be a rotatable wheel hub for a vehicle. A shaft, indicated in dotted lines at **13**, extends through the seal assembly **10**. The shaft **13** may, for example, be an axle spindle for a vehicle which rotatably supports the wheel hub **12** thereon. Typically, the housing **12** also moves axially and radially relative to the shaft **13** during operation, although by relatively small amounts. As will be explained in detail below, the seal assembly **10** functions to retain lubricant within the housing **12**, while permitting relative rotational, axial, and radial movement of the housing **12** relative to the shaft **13**. In the illustrated embodiment, the space **14** indicates the lubricant side of the seal assembly **10**, while the space **15** indicates the external environment.

The seal assembly **10** includes an annular metallic inner case, indicated generally at **20**. The inner case **20** is generally U-shaped in cross section, having a first radially extending leg portion **21**, a second leg portion **22** extending axially from the innermost end of the first leg portion **21**, and a third leg portion **23** extending radially outwardly from the end of the second leg portion **22** opposite the first leg portion **21**. The second portion **22** has an inner circumferential surface **22*a*** and an outer circumferential surface **22*b***. The inner circumferential surface **22*a*** has a layer **24** of resilient material, such as nitrile rubber, adhered thereto by conventional means.

The resilient layer **24** may be formed having a convoluted inner surface which, in the illustrated embodiment, may be generally ramp-shaped in cross section. Portions of the convoluted inner surface define an inner diameter which is smaller than the outer diameter of the shaft **13**. Thus, those portions of the resilient layer **24** are compressed when the shaft **13** is inserted through the inner case **20**. As a result, the inner case **20** is secured to the shaft **13** during operation. The convoluted portions of the resilient layer **24** are formed having the ramp-like configuration to facilitate installation of the inner case **20** onto the shaft **13** in one axial direction, yet resist removal thereof in the opposite axial direction.

The seal assembly **10** also includes an annular metallic outer case, indicated generally at **30**. As shown in the drawing, the outer case **30** has a convoluted cross sectional shape defined by six leg portions. A first leg portion **31** of the outer case **30** extends radially. A second leg portion **32** of the outer case extends axially from the outermost end of the first leg portion **31**. The second leg portion **32** has an inner circumferential surface **32*a*** and an outer circumferential surface **32*b***. The outer circumferential surface **32*b*** of the second leg portion **32** is press fit into the bore **11** of the housing **12**. Thus, unlike the inner case **20** which is mounted on the shaft **13**, the outer case **30** is mounted on the housing **12** during operation.

A third leg portion 33 of the outer case 30 extends radially outwardly from the end of the second leg portion opposite the first leg portion 31. Thus, the first leg portion 31 and the third leg portion 33 of the outer case 30 define an axially extending space therebetween, the purpose of which will be explained below. A fourth leg portion 34 extends axially from the innermost end of the third leg portion 33. A fifth leg portion 35 extends radially inwardly from the end of the fourth leg portion 34 opposite the third leg portion 33. Finally, a sixth leg portion 36 extends axially from the innermost end of the fifth leg portion 35.

As shown in the drawing, the outer case 30 is disposed generally concentrically about the inner case 20. A portion of the fifth leg portion 35 of the outer case 30 extends adjacent to, but is spaced apart from, the first leg portion 21 of the inner case 20. These adjacent portions of the inner case 20 and the outer case 30 define an axially extending space therebetween, which is identified as "A" in the drawing. The purpose of this axially extending space "A" will be explained below.

The seal assembly 10 further includes an annular metallic shield, indicated generally at 40. The shield 40 has an inverted-L cross sectional shape, having an axially extending leg portion 41 and a radially extending leg portion 42. The axially extending leg portion 41 is disposed adjacent to the second leg portion 32 of the outer case 30, while a portion of the radially extending leg portion 42 is disposed adjacent to the third leg portion 33. In practice, the first leg portion 31 of the outer case 30 is initially formed parallel with the second leg portion 32. The axially and radially extending portions 41 and 42 of the shield 40 are disposed adjacent the second and third leg portions 32 and 33, respectively. Then, the first leg portion 31 of the outer case 30 is rolled radially inwardly as shown in the drawing. As a result, the shield 40 is securely engaged to the outer case 30. One or more apertures 43 are formed through the radially extending leg portion 42 of the shield 40. The purpose of these apertures 43 will be explained below.

Thus, it can be seen that the shield 40 is supported concentrically within the outer case 30. As shown in the drawing, a portion of the radially extending leg portion 42 of the shield 40 extends adjacent to, but is spaced apart from, the third leg portion 23 of the inner case 20. These adjacent portions of the inner case 20 and the shield 40 define an axially extending space therebetween, which is identified as "B" in the drawing. The purpose of this axially extending space "B" will be explained below. Also, the innermost end of the radially extending leg portion 42 is disposed adjacent to, but is spaced apart from, the inner circumferential surface 22*a* of the second leg portion 22 of the inner case. These adjacent portions of the inner case 20 and the shield 40 define a radially extending space therebetween, which is identified as "C" in the drawing. The purpose of this radially extending space "C" will be explained below.

Lastly, the seal assembly 10 includes an annular seal member, indicated generally at 50. The seal member 50 is formed from a resilient elastomeric material, such as nitrile rubber. The seal member 50 has a base portion 50*a* which is bonded to the sixth leg portion 36 of the outer case 30. A first flexible lip 51 extends generally axially from the base portion 50*a* into sealing engagement with the first leg portion 21 of the inner case 20. A second flexible lip 52 extends generally radially from the base portion 50*a* into sealing engagement with the second leg portion 22 of the inner case 20, adjacent to the first leg portion 21. A third flexible lip 53 also extends generally radially from the base portion 50*a* into sealing engagement with the second leg portion 22 of the inner case 20, but adjacent to the third leg portion 23. A conventional garter spring 54 extends about the inner portion of the third flexible lip 53, urging it into sealing engagement with the second leg portion 22 of the inner case 20.

In operation, the seal assembly 10 is installed in the housing by press fitting the outer case 30 into the bore 11. Then, the shaft 13 is inserted through the inner case 20. During normal operation, the housing 12 and the shaft 13 rotate generally concentrically relative to one another and, therefore, relative to the seal assembly 10. However, as mentioned above, the housing 12 may also move both axially and radially relative to the shaft 13. Thus, the outer case 30, the shield 40, and the seal member 50 not only rotates relative to the inner case 20, but also move axially and radially relative thereto. The clearances "A", "B" and "C" discussed above are provided to accommodate such relative movement of the inner case 20. The clearance "A" also restricts the entry of dirt and other contaminants into the interior of the seal assembly 10, thus protecting the seal member 50 therefrom.

Throughout such relative axial and radial movements of the housing 12 and the shaft 13, the flexible lips 51, 52, and 53 of the seal member 50 engage the leg portions 21 and 22 of the inner case 20 to provide a seal therebetween. As discussed above, the first flexible lip 51 resiliently engages the first radially extending leg portion 21 of the inner case 20. The first flexible lip 51 functions as the primary seal to prevent dirt and other contaminants from entering within the seal assembly 10. Because of its flexibility, the first flexible lip 51 maintains contact with the first leg portion 21 of the inner case 20 when the shaft 13 and the inner case 20 move axially relative to the housing 12 and the outer case 30.

As also discussed above, the second and third flexible lips 52 and 53 resiliently engage axially extending second leg portion 22 of the inner case. The second flexible lip 52 functions as a secondary seal, also to prevent dirt and other contaminants from entering within the seal assembly 10. The third flexible lip 53 functions as the oil seal, preventing lubricant from draining from the interior space 14 to the exterior space 15. Because of their flexibility, the second and third flexible lips 52 and 53 maintain contact with the second leg portion 22 of the inner case 20 when the shaft 13 and the inner case 20 move radially relative to the housing 12 and the outer case 30.

As discussed above, clearances "A" "B" and "C" are provided between portions of the inner case 20, the outer case 30, and the shield 40. These clearances are designed to accommodate the axial and radial movement of the housing 12 (and the outer case 30 and the shield 40 mounted thereon) relative to the shaft 13 (and the inner case 20 mounted thereon). The apertures 43 are provided to permit lubricant to flow freely from the interior space 14 to the inside area of the seal assembly 10. This prevents any suction or vacuum effect from occurring in the seal assembly 10 as a result of continuous reciprocating movement of the inner case 20 relative to the outer case 30 and the shield 40.

In accordance with the provisions of the patent statutes, the principle and mode of operation of this invention have been explained and illustrated in its preferred embodiment. However, it must be understood that this

invention may be practiced otherwise than as specifically explained and illustrated without departing from its spirit or scope.

What is claimed is:

1. A seal assembly for providing a seal between a shaft extending through a bore formed in a housing and the housing, the seal assembly comprising:

an inner case adapted to be mounted on the shaft, said inner case including an axially extending leg portion and a radially extending leg portion;

an outer case adapted to be mounted on the housing within the bore and about said inner case, said outer case including first and second radially extending leg portions;

a shield including an axially extending leg portion and a radially extending leg portion, said axially extending leg portion being engaged by said first and second radially extending leg portions of said outer case so as to secure said shield thereto; and

a resilent seal member attached to said outer case at a first radial location relative to said inner case and disposed between said radially extending leg portion of said inner case and said radially extending leg portion of said shield, said seal member engaging both said axially extending leg portion of said inner case and said radially extending leg portion of said inner case at second and third radial locations, respectively, relative to said inner case to provide a seal between the shaft and the housing, said first radial location being radially outward from both said second and third radial locations.

2. The seal assembly defined in claim 1 wherein a portion of said radially extending leg portion of said inner case extends adjacent to, but is spaced apart from, a portion of said outer case.

3. The seal assembly defined in claim 1 wherein said inner case further includes a second radially extending leg portion, a portion of said second radially extending leg portion of said inner case extending adjacent to, but spaced apart from, a portion of said radially extending leg portion of said shield.

4. The seal assembly defined in claim 1 wherein said shield includes an aperture formed through said radially extending leg portion.

5. The seal assembly defined in claim 1 wherein said radially extending leg portion of said shield terminates adjacent to, but spaced apart from, said axially extending leg of said inner case.

6. The seal assembly defined in claim 1 wherein said inner case has a layer of resilient material adhered to an inner circumferential surface of said axially extending leg portion, said layer adapted to mount said inner case on the shaft.

7. The seal assembly defined in claim 6 wherein said layer has a convoluted inner surface.

8. The seal assembly defined in claim 7 wherein said convoluted inner surface is generally ramp-shaped in cross section.

9. The seal assembly defined in claim 1 wherein said seal member includes a first flexible lip which resiliently engages said radially extending leg of said inner case.

10. The seal assembly defined in claim 9 wherein said seal member further includes a second flexible lip which resiliently engages said axially extending leg of said inner case.

11. The seal assembly defined in claim 10 wherein said seal member further includes a third flexible lip which also resiliently engages said axially extending leg of said inner case.

12. The seal assembly defined in claim 11 wherein said seal member further includes a garter spring disposed about said third flexible lip for urging it to resiliently engage said axially extending leg of said inner case.

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